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Updating of the Wind Design Standard for Mexico City

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SUMMARY:
In recent years, Mexico City has experienced an increase in the development of low-rise and high-rise buildings that requires the improvement of codal guidelines to provide safe structures under wind loading. The current Wind Design Standard for Mexico City is been updating to include state-of-the art methods of analysis as well as recent advances in wind engineering in Mexico and abroad. The main objective of this work is to present the main changes performed in the Wind Design Standard for Mexico City, with particular emphasis in the Regional Velocity, Static and Dynamic effects. As other updated Mexican standards, the changes suggested for the new version of the Wind Design Standard for Mexico City are guided towards a better understanding of the wind phenomenon on structures by using practical guidelines.

Keywords: regional wind speed, static wind effects, dynamic wind effects

1. INTRODCUTION

As any other code or standard, wind design codes and standards are legal documents with the aim of protecting the society against the failure or malfunction of wind-sensitive structures. In Mexico, the Manual of Civil Structures for Wind Design (MCSWD, 2020), which is widely used in different sites of Mexico for wind design, was recently updated to include state-of-the art methods of analysis as well as recent advances in wind engineering in Mexico and abroad. At a local level, Mexico City has its own wind design standard (NTC-V as per its acronym in Spanish). The current NTC-V (2017) includes general guidelines for its use and application, characterization of the wind hazard in terms of regional wind speed as well as static and dynamic characterization of the wind effects on structures. The NTC-V has been updated with certain regularity, Fig. 1 presents a schematic representation of the evolution of the Mexico City Design Code and the NTC-V along the years, including all the updates.

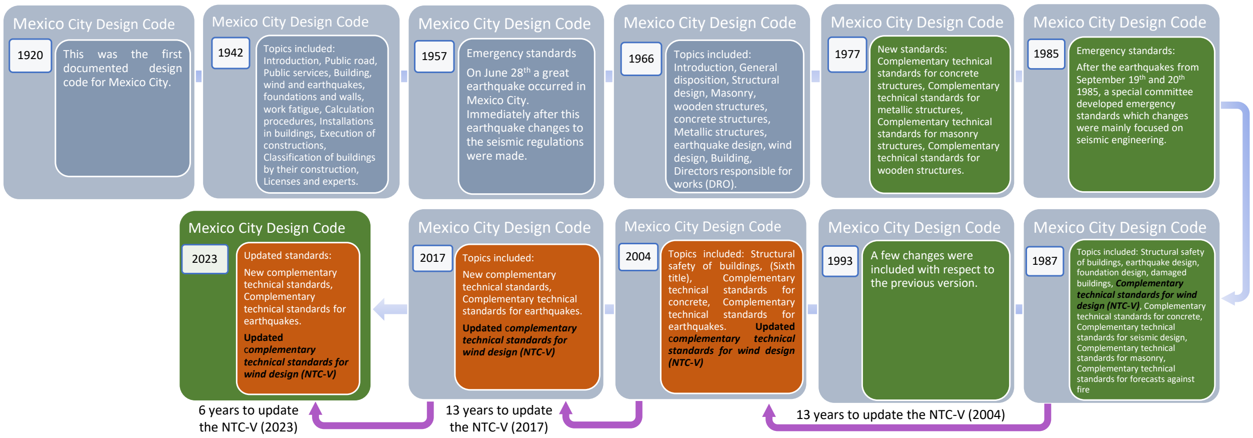

Figure 1. Evolution of the Mexico City Design Code and NTC-V along the years, including all the updates of NTC-V (figure prepared with information from González-Cuevas, 2022).

It is observed in Fig. 1 that the current NTC-V (2017) has been updated twice from the 1987 version, the periodicity of the updates is 13 years. For the new updated version, which is to be published by the end of 2023, the period of time for updating was reduced to 6 years. It is noted that, according to the new Mexico City regulations for the updating of code and standards, the new periodicity of the updates was set to 6 years.
The main objective of this work is to present an overview of the updated Wind Design Standard for Mexico City. The description of the updated document is organized into three sections: regional wind speed, static and dynamic effects. Details about the most important changes with respect to the 2017 version are given and the similitudes with other major international wind design codes are discussed.

2. REGIONAL WIND SPEED

The regional wind speed (basic wind speed) is used in the calculation of the design wind speed. The current NTC-V (2017) includes a table with values of 3 second gust regional wind speed at 10 m height for open terrain and for three different return periods (i.e., 10, 50 and 200 years). The updated version of the NTC-V includes contour maps with 3 second gust regional wind speed at 10 m height for open terrain for the same return period values that the current version. This is the first time that contour maps are developed to present regional wind speed in the NTC-V. For the development of the wind speed contour maps, information of whether stations from three different meteorological networks were used. Table 1 presents a summary of the number of meteorological stations employed from each network.

Table 1. Networks and meteorological stations.

Network	Name of meteorological stations
Program of meteorological stations of the universitary baccalaureate (PEMBU)	Centro de Ciencias de la Atmósfera, CCH Vallejo, CCH Sur, CCH Oriente, CCH Naucalpan, CCH Azcapotzalco, Gabino Barreda, Erasmo Castellanos, Justo Sierra, Vidal Castañeda, José Vasconcelos, Antonio Caso, Ezequiel Chávez, Miguel Schulz, Pedro de Alba.
Atmospheric monitoring system of Mexico City (SIMAT)	FES Acatlán, Tlahuac, Montecillo, Tlalpan, Cuajimalpa, Villa de las flores, Hangares, Plateros, Cerro de la Estrella, Pedregal,
National meteorological system (SMN)	Cuernavaca, Chapingo, Merced, Pachuca, Puebla, Tlalnepantla, Tacubaya, Tulancingo, Toluca, Tlaxcala, San Agustin, Xalostoc.

Exposure and topographic corrections were applied to the wind speed values from each meteorological station. The methodology used for the corrections was guided by ESDU (2002) and engineering judgment.

3. STATIC WIND EFFECTS ON STRUCTURES

3.1 Wind pressure for cladding

The pressure coefficients employed in the current NTC-V (2017) to evaluate the wind pressures over cladding elements are not completely consistent with the pressure coefficients propose in major international codes (e.g., ASCE-7, 2022; NBCC, 2015; AIJ, 2004). To homologate the pressure coefficients with the trends and tendencies observed from wind tunnel tests and international codes, where it has been observed that wind pressure coefficients are function of the logarithm of the tributary area (i.e., $\log(A)$), all the functional forms of the pressure coefficients for cladding were updated. It is noted that just the functional form of the expressions was updated, but the upper and lower bounds of the magnitude were preserved. The later was decided based on engineering judgment and that there was no evidence of cladding failures in Mexico City.

A new section was included in the updated version of the NTC-V, which includes a methodology to calculate the thickness and deflection of glass panels for low-rise buildings under wind loading.

3.2 Static wind pressure for structures

The current NTC-V (2017) includes procedures to evaluate static wind pressure effects for some basic forms. Due to the fast growing of infrastructure in Mexico City, several types of structures have been built and wind effects have been evaluated with engineering judgment due to the lack of technical information. The updated version of the NTC-V has included other type of structures frequently built in Mexico City. Table 2 presents a summary of the structures included in the updated version of the standard that are sensitive to static wind effects.

Table 2. Structures included in the updated version of the standard that are sensitive to static wind effects.

Structure
Closed buildings and constructions, circular arch roof, Cantilevered roofs on stands, insulated roofs, solar panels on building roofs, Isolated walls, isolated ads, flags, Chimneys and support elements, silos and cylindrical tanks, Insulated lattice towers and telecommunication towers and accessories, structural profiles and pedestrian bridges.

Similar to other international wind design codes and standards, the updated NTC-V includes methodologies to calculate the wind static pressure and forces with detail guidelines regarding the way such pressures have to be applied. It is noted from Table 2 that pedestrian bridges were included in the updated version, the reason for including this type of structure is because Mexico City does not have yet a bridge design standard.

4. DYNAMIC WIND EFFECTS ON STRUCTURES

The use of Davenport's methodology (1964) to evaluate the wind-induced response of a structure or variations of it have been adopted in several international wind design codes. In Mexico City, the 1987, 1993 and 2004 versions of the NTC-V adopted Davenport's approach to evaluate the dynamic wind effects on structures. The current NTC-V (2017) was updated to modified the way the dynamic wind effects were evaluated, for such version, the method of dynamic analysis is based on Solari's work (1982, 1993a, 1993b), where a closed form solution was developed to estimate the alongwind response. The aim of the change was to homologate the NTC-V and the Manual of Civil Structures for Wind Design, which is a document frequently employ in different parts of Mexico for wind design. For the updated version of the NTC-V, the dynamic wind effects kept Solari's approach (1982, 1993a, 1993b). A new procedure was included in the updated version of the NTC-V to evaluate wind-induced acceleration for tall buildings that takes into account the wind climate for Mexico City. This procedure is based on the work by Pozos-Estrada (2018).

5. FINAL REMARKS

The updated version of the NTC-V includes new methodologies to evaluate the wind-induced response for different type of structures. Part of the updating included the verification and evaluation of consistency of all the information with new wind engineering findings from Mexico and abroad. The updating included not only methodologies and procedures, but newly contour wind maps, which are the first time to be developed for Mexico City by using local meteorological stations.

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